PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : B04B 11/06

A1

(11) International Publication Number: WO 91/12082

(43) International Publication Date: 22 August 1991 (22.08.91)

(21) International Application Number: PCT/SE91/00100

(22) International Filing Date: 13 February 1991 (13.02.91)

(30) Priority data:
9000540-6 15 February 1990 (15.02.90) SE

(71) Applicant *(for all designated States except US)*: ALFA-LAVAL SEPARATION AB [SE/SE]; S-147 80 Tumba (SE).

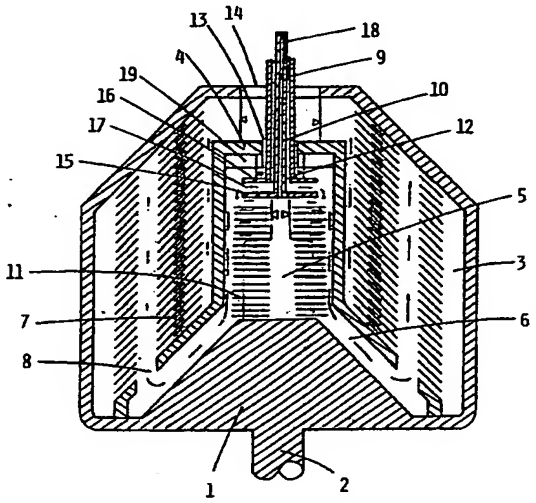
(72) Inventors; and
(75) Inventors/Applicants *(for US only)* : BORGSTRÖM, Leonard [SE/SE]; Skebokvarnsvägen 269, 3 tr., S-124 35 Bandhagen (SE). CARLSSON, Claes, Göran [SE/SE]; Skoghemsvägen 63 B, S-146 00 Tullinge (SE). FRANZÉN, Peter [SE/SE]; Månstorpsvägen 22, S-146 00 Tullinge (SE). INGE, Claes [SE/SE]; Kristinavägen 15, S-131 50 Saltsjö-Duvnäs (SE). LAGERSTEDT, Torgny [SE/SE]; Döbelnsgatan 89, S-113 52 Stockholm (SE). MOBERG, Hans [SE/SE]; Bellmansgatan 21, 2 tr., S-116 47 Stockholm (SE). NÄBO, Olle [SE/SE]; Nordanvägen 15, S-146 00 Tulline (SE).

(74) Agent: CLIVEMO, Ingemar; Alfa-Laval AB, S-147 80 Tumba (SE).

(81) Designated States: AT (European patent), BE (European patent), BR, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US.

Published
With international search report.

(54) Title: CENTRIFUGAL SEPARATOR WITH ANNULAR DISCS IN THE INLET CHAMBER



(57) Abstract

Centrifugal separator with a rotor (1), which is supported by a driving shaft (2) and forms a separation chamber (3) and an inlet chamber (5), which is delimited by a dividing wall (4). The centrifugal separator has an inlet tube (9), which extends axially through the dividing wall (4) at one axial end of the inlet chamber, at which the inlet channel (10) in the tube (9) opens. In the inlet chamber (5) there is arranged a number of entraining discs (11). A central part of the inlet chamber (5) is connected to a space outside the same through an evacuating channel (13, 18). In order to accomplish a centrifugal separator having an inlet device, which efficiently and gently entrains a supplied liquid mixture without demanding a large space in the centrifugal separator, it is provided with a baffle (15), which between the opening of the inlet channel (10) and the discs extends from the rotational axis of the rotor and delimits a liquid filled inlet space (17), in which liquid flows during operation from the inlet channel radially outwards into the liquid body.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	ES	Spain	MG	Madagascar
AU	Australia	FI	Finland	ML	Mali
BB	Barbados	FR	France	MN	Mongolia
BE	Belgium	GA	Gabon	MR	Mauritania
BF	Burkina Faso	GB	United Kingdom	MW	Malawi
BG	Bulgaria	GN	Guinea	NL	Netherlands
BJ	Benin	GR	Greece	NO	Norway
BR	Brazil	HU	Hungary	PL	Poland
CA	Canada	IT	Italy	RO	Romania
CF	Central African Republic	JP	Japan	SD	Sudan
CG	Congo	KP	Democratic People's Republic of Korea	SE	Sweden
CH	Switzerland			SN	Senegal
CI	Côte d'Ivoire	KR	Republic of Korea	SU	Soviet Union
CM	Cameroon	LI	Liechtenstein	TD	Chad
CS	Czechoslovakia	LK	Sri Lanka	TG	Togo
DE	Germany	LU	Luxembourg	US	United States of America
DK	Denmark	MC	Monaco		

Centrifugal separator with annular discs in the inlet chamber

The present invention concerns a centrifugal separator comprising a rotor, which is supported by a driving shaft and forms a separation chamber and a centrally located inlet chamber, the latter communicating with the separation chamber through channels distributed around the rotational axis and being delimited by a dividing wall at one of its axial ends. The centrifugal separator also comprises an inlet tube having an inlet channel extending axially through the dividing wall and opening in the inlet chamber at said one of its axial ends, a stack of annular acceleration discs coaxial with the rotor, the discs being rotatable with the rotor and arranged at an axial distance from each other in the inlet chamber between the opening of the inlet channel and the second axial end of the inlet chamber to bring a supplied liquid during operation to rotate with the rotor and form a rotating liquid body in the inlet chamber. In the centrifugal separator there is arranged an evacuating channel, which connects a central part of the inlet chamber to a space outside the same.

A problem in connection with centrifugal separators of this kind is to bring the liquid supplied through the inlet tube to rotate with the rotor without a dispersed phase of the liquid being splitted by the shearing forces acting on the same, which makes the following separation of this phase out of the liquid more difficult. An efficient and gentle acceleration of the liquid is thus desired for obtainment of a maximum separation result in the centrifugal separator. A kind of acceleration and entrainment member often used is wings, which extend axially and radially and are supported by the rotor in the inlet chamber. However. these wings give rise to heavy strains on the supplied liquid in the form of shocks and shearing forces. If the inlet chamber is not filled during the operation all the way to the centre,

these wings cause, in addition, splashing of the incoming liquid, which means that air is mixed with the liquid.

A proposed solution of the described problem is shown in the US patent specification 2,302,381. The centrifugal separator shown therein has a rotor, which inside itself forms a separation chamber and an inlet chamber, the latter communicating with the separation chamber. The liquid mixture of components, which are to be separated, is supplied to the inlet chamber centrally through an inlet channel in the vertical driving shaft of the rotor. Inside the inlet chamber there is arranged a stack of annular discs, which are rotatable with the rotor. The centre of the discs coincides with the rotational axis of the rotor. Centrally every disc has a circular opening, which openings together form a reception chamber for the supplied liquid mixture. Between themselves the discs form passages through which the liquid mixture is intended to flow radially outwards towards the separation chamber.

In the centrifugal separator known from US 2,302,381 the inlet channel ends below the said reception chamber. The inlet channel has an opening directed axially towards the reception chamber, the flow through the opening being strongly restricted. Upon supply of liquid mixture through the inlet channel, hereby, a jet is created, which passes through the reception chamber and hits a deflection member. This deflection member rotates with the rotor and deflects the liquid mixture in the jet radially outwards towards the annular discs, between which the liquid mixture flows further on towards the separation chamber.

In the passages between the discs the supplied liquid is brought to rotate with the rotor without being exposed to

as heavy strains as entraining members in the form of wings give rise to in the same circumstances. On the contrary, both the strong restriction of the flow at the opening of the inlet channel and the collision between the created jet and the conical deflection member result in a strong turbulence and splitting of the components of the liquid mixture, which in many cases makes it impossible to achieve a satisfactory separation result.

In US 4,721,505 there is shown an inlet device in a centrifugal separator, in which the supplied liquid mixture is intended to be accelerated in passages between discs of the same kind as the discs according to US 2,302,381. In this inlet device the liquid mixture is supplied through a supply member to a central reception chamber, which is formed by central openings in the annular discs. An evacuating channel is connected to one of the axial ends of the reception chamber. Between the opening of the supply member in the reception chamber and the connection thereto of the evacuating channel a number of the discs are located. At the opening of the supply member a liquid body is maintained during operation, which extends through at least some of the passages between the discs. The supply member is so designed that the liquid mixture supplied through the same forms a liquid phase, which is continuous with the liquid body.

In the inlet device according to US 4,721,505 the supply member extends axially through the central openings of a number of the discs. This limits the possible extension of the discs radially inwards, which in turn limits the entraining capability of the discs. In order to compensate for this and achieve the same maximum capacity the number of discs has to be increased, which means that the axial extension of the disc stack increases correspondingly. Besides, if the supply member is

stationary it is necessary that there is a gap between this and the discs rotating with the rotor, which is big enough to prevent that the discs collide with the supply member when the rotor will oscillate. This means that the supply member has to be assembled with a very high degree of accuracy if the gap is not relatively big, which limits the radial extension of the discs further.

The object of the present invention is to accomplish a centrifugal separator with an inlet device which efficiently and gently can entrain a supplied liquid mixture without the need of requiring large space in the centrifugal separator.

This object is achieved according to the invention by providing the centrifugal separator initially described with a baffle, which extends from the rotational axis of the rotor radially outwards between the opening of the inlet chamber and the discs in a way such that it during operation will dip into the rotating liquid around the rotational axis, and which delimits a liquid filled inlet space, which is separated from the rest of the inlet chamber, and through which liquid during operation of the rotor will flow radially outwards into the liquid body.

The invention will be described in the following more closely with reference to the accompanying drawings, in which the figures 1-3 show different embodiments of a centrifugal separator according to the invention.

The centrifugal separator schematically shown in figure 1 has a rotor body 1, which is supported by a driving shaft 2. The rotor body forms inside itself a separation chamber 3. Centrally in the rotor there is arranged a wall element , which forms a dividing wall 4 and together with part of the rotor body delimits an inlet chamber 5.

The inlet chamber 5 communicates with the separation chamber 3 through channels 6, which are formed between the wall element and the rotor body 1. In the separation chamber 3 there as arranged a stack of frusto-conical separation discs 7, which divide the separation chamber 3 in a number of interspaces, in which the main separation is taking place. Axially through the stack of separations discs 7 a number of passages 8 extend, which are formed by just above each other located holes in the discs.

From above in fig 1 a stationary inlet tube 9 with an internal inlet channel 10 extends axially through a central opening in the rotor body 1 into the rotor and further on through a central opening in the dividing wall 4 into the inlet chamber 5, in which it opens at one axial end thereof. In the inlet chamber 5 there is arranged a stack of annular discs 11, which are rotatable with the rotor, between the opening 12 of the inlet channel and the opposite end of the inlet chamber 5. The discs 11 are kept at a distance from each other by means of distance means , which are arranged on the discs. Hereby , a number of passages are formed between the discs 11. The stack formed by the discs 11 are fixedly joined to the rotor body 1 and/or the dividing wall. The object of the discs is to bring a supplied liquid during operation to rotate with the rotor and form a rotating liquid body in the inlet chamber 5. The discs 11 extend in a plan essentially perpendicular to the rotational axis of the rotor and their centre coincides with the rotational axis.

The central part of the inlet chamber 5 communicates with the space outside the same through an evacuating channel 13 in the form of a gap between the stationary inlet tube 9 and the edge of the central opening in the dividing wall 4. There is also a similar gap 14 between the

stationary inlet tube 9 and the edge surrounding the central opening in the rotor body 1. Hereby, the central part of the inlet chamber 5 also communicates with the space outside the rotor body 1. Between the opening 12 of the inlet channel and the discs 11 a baffle 15 extends from the rotational axis of the rotor radially outwards into the during operation rotating liquid body in the inlet chamber 5. The baffle 15 is in the embodiment shown in fig 1 stationary and fixedly joined with and supported by the stationary inlet tube 9. However, it is quite possible to fixedly connect the baffle 15 rotatable to the dividing wall and/or to the stack of the discs 11. The stationary inlet tube 9 is at its end in the inlet chamber 5 provided with an external annular flange 16. This flange 16 extends essentially parallel to the baffle 15 out into the during operation rotating liquid body in the inlet chamber. The baffle 15 and the flange 16 delimit thembetween an inlet space 17, which during operation is filled with supplied liquid, which flows from the inlet channel 10 radially outwards into the rotating liquid body. Centrally through the inlet tube 9 and the baffle 15 an evacuating channel 18 extends, which connects the central, during operation gas filled, part of the inlet chamber 5 below the baffle 15 to the surrounding of the rotor. Through this evacutating channel gas, which during operation is located radially inside the rotating liquid body in this part of the inlet chamber 5, can flow out of the inlet chamber 5.

In the inlet chamber 5 a number of radially extending wings 19 also can be arranged on the dividing wall 4 in the space between the flange 16 and the evaporating channel 13. Hereby it is guaranteed that the liquid, which is located during operation in this space, is entrained with the rotation of the rotor enough efficiently to maintain the free liquid surface of the

rotating liquid body in this space radially outside the evacuating channel 13.

The centrifugal separator schematically shown in fig 2 differs from the centrifugal separator shown in fig 1 in that the inlet tube consists of the driving shaft 20 rotating with the rotor, which inside itself forms an inlet channel 21. The inlet channel 21 opens in an inlet chamber 22, which in the same manner as in fig 1 is delimited partly by the rotor body, partly by the wall element 23. In this case the rotor body forms the dividing wall 24, through which the inlet channel extends into the inlet chamber 22. The inlet chamber communicates through a number of channels 25 with a separation chamber 26, which is formed in the rotor and is provided with a stack of frusto-conical separation discs 27. As in fig 1 a number of annular acceleration discs 28 rotatable with the rotor are arranged centrally in the inlet chamber 22 between the opening of the inlet channel 21 and the opposite end of the inlet chamber. These discs 28 are also kept at a distance from each other by means of distance means, which are arranged on the discs 28. The stack formed by these discs 28 is fixedly joined with the rotor body 1 and/or the dividing wall. Between these discs 28 and the opening of the inlet channel 21 there is arranged a baffle 29, which extends from the rotational axis of the rotor radially outwards into the during operation rotating liquid body in the inlet chamber 22. The baffle 29 is in this embodiment rotatable with the rotor and is preferably fixedly connected to the part of the rotor which forms the dividing wall 24. Together with the dividing wall 24 the baffle 29 forms an inlet space 30, which during operation is filled with liquid, which flows from the inlet channel 21 radially outwards into the rotating liquid body. Centrally through the wall element 23 at its opposite end an evacuating channel 31

extends, which connects a central part of the inlet chamber 22, which during operation is filled with a gas, to a gas filled space outside the inlet chamber 22. In this embodiment the channels 25 between the inlet chamber 22 and the separation chamber 26 are connected to the inlet chamber 22 at the end of the same, at which the inlet channel 22 opens, i.e. on the same side of the entraining discs 28 as the opening of the inlet channel 21.

The centrifugal separator schematically shown in fig 3 has an inlet tube, which in the same manner as the inlet tube in the embodiment shown in fig 2 consists of the driving shaft 32 rotating with the rotor. This driving shaft 32 forms an inlet channel 33 too, which opens into the central inlet chamber 34. The inlet chamber 34, which is delimited partly by the rotor body 35, partly by the wall element 36, is surrounded by a separation chamber 33 and communicates with it through channels 38. In the separation chamber 37 there is arranged a stack of frusto-conical separation discs 39. The dividing wall, which delimits the inlet chamber 34, and through which the inlet channel 33 extends, is also in this embodiment formed by a part of the rotor body 35. The inlet channel 33 opens into one axial end of the inlet chamber 34 and between this end and its opposite end there is arranged a stack of a number of annular discs 40 rotatable with the rotor provided with distance means to bring during operation a supplied liquid to rotate with the rotor and form a rotating liquid body in the inlet chamber 34. The stack of the discs 40 is as a suggestion fixedly connected to the rotor body but can also be fixedly connected to the wall element 36. The discs 40 extend essentially in a plan perpendicular to the rotational axis of the rotor and the centre of them coincides with the rotational axis. Between the discs 40 and the opening

of the inlet channel 33 there is arranged a baffle 41, which is fixedly connected to the rotor body 35, together with which it forms an inlet space 42. In this embodiment the discs 40 have a central hole, the diameter of which decreases with the distance from the baffle 41. Centrally through the wall element 36 at the opposite end of the inlet chamber 34 there is an evacuating channel 43, which connects central spaces of the rotor, which during operation are filled with gas, to each other.

In this embodiment the channels 38, which connect the inlet chamber 34 to the separation chamber 37, are connected to the inlet chamber 34 radially outside the discs 40, at the end of the disc stack , which is turned from the inlet channel.

The centrifugal separator shown in fig 1 functions in the following manner.

While the rotor is rotating the liquid mixture components, which are to be separated, is supplied through the inlet channel 10 and the inlet space 17 to the inlet chamber 5. In the inlet chamber the liquid passes in thin layers between the entraining discs 11 , which brings the liquid to rotate and form a rotating liquid body in the inlet chamber with a radially inwards directed free liquid surface. The inlet space 17 is then filled, whereby the liquid flowing through the inlet channel 10 and the inlet space 17 forms a continuous liquid phase with a liquid body rotating in the inlet chamber 5. To guarantee when the supply flow of liquid is high that the free liquid surface of the part of the rotating liquid body, which is located above the inlet space 17, does not move radially inwards further than to the radially innermost edge of the dividing wall

4, the liquid in this part of the inlet chamber is also entrained by a number of radially wings 19.

The liquid mixture flows from the inlet chamber 5 through the channel 6 and further up through the passages 8. From the passages 8 the mixture is distributed out into the different interspaces between the separation discs 7 where the main separation is taking place.

During the separation in these interspaces a specific heavier component is separated from a specific lighter component influenced by the centrifugal force. The specific lighter component then flows radially inwards between the discs and further towards a central outlet, which in the figure is shown in the form of a overflow outlet. The specific heavier component flows radially outwards in the interspace and is accumulated in the radially outermost part of the separation chamber 3.

The centrifugal separators shown in figs 2 and 3 also function in a corresponding manner.

At a certain inlet flow of the liquid mixture to the centrifugal separators shown in the figures the free liquid surface of the rotating liquid body in the inlet chamber 5 takes the positions, which are illustrated by the continuous lines and small triangles in the figures. If the inlet flow of the mixture increases the liquid surface will be displaced radially in a way such that the liquid flows in more and more interspaces between the entraining discs. In the embodiment shown in fig 3 bigger and bigger entraining discs will, in addition, be active when the supply of the mixture increases, whereby a great need of entrainment can be satisfied.

By designing a centrifugal separator in this manner with an inlet device, which efficiently and gently entrains the supplied mixture without demanding a large space in the centrifugal separator, a space in the same is made free, which, for instance, can be used for an outlet device, such as a paring device.

Claims

1. Centrifugal separator having

- a rotor, which is supported by a driving shaft (2, 20, 32) and forms a separation chamber (3, 26, 37) and a centrally located inlet chamber (5, 22, 34), the latter communicating with the separation chamber (3, 26, 37) through channels (6, 25, 38) distributed around the rotational axis and being delimited by a dividing wall at one of its axial ends,

- an inlet tube (9, 20, 32) having an inlet channel (10, 21, 33) extending axially through the dividing wall (4, 24, 35) and opening in the inlet chamber (5, 22, 34) at said one of its axial ends,

- a stack of annular acceleration discs (11, 28, 40), coaxial with the rotor, the discs being rotatable with the rotor and arranged at an axial distance from each other in the inlet chamber (5, 22, 34) between the opening of the inlet channel (10, 21, 33) and the second axial end of the inlet chamber (5, 22, 34) to bring a supplied liquid during operation to rotate with the rotor and form a rotating liquid body in the inlet chamber (5, 22, 34), and

- an evacuating channel (13, 18, 31, 43), which connects a central part of the inlet chamber to a space outside the same,

c h a r a c t e r i z e d i n

a baffle (15, 29, 41) which extends from the rotational axis of the rotor radially outwards between the opening of the inlet channel (10, 21, 33) and the discs (11, 28,

40) in a way such that it during operation will dip into the rotating liquid body around the rotational axis, and which delimits an inlet space (17, 30, 42), which is separated from the rest of the inlet chamber, and through which liquid during operation of the rotor will flow from the inlet channel (10, 21, 33) radially outwards into the liquid body.

2. Centrifugal separator according to claim 1, c h a r a c t e r i z e d i n that the baffle extends radially outwards to a level outside the radial inner edges of at least some of the discs.

3. Centrifugal separator according to claim 1 or 2, c h a r a c t e r i z e d i n that the inlet tube (9) is stationary and extends axially through a central opening in the dividing wall.

4. Centrifugal separator according to claim 3, c h a r a c t e r i z e d i n that a circular flange (16) is arranged on the outside of the inlet tube (9), the flange extending during operation radially outwards into the rotating liquid body around the rotational axis and forming together with the baffle (15) said inlet space (17).

5. Centrifugal separator according to claim 1 or 2, c h a r a c t e r i z e d i n that the inlet tube (20, 32) is rotatable with the rotor and connected to the dividing wall (24, 35).

6. Centrifugal separator according to claim 5, c h a r a c t e r i z e d i n that the inlet tube consists of the driving shaft (20, 32).

7. Centrifugal separator according to any of the preceding claims, c h a r a c t e r i z e d i n that said baffle (15, 29, 41) is fixedly joined to the rotor.

8. Centrifugal separator according to any of the claims 1-4, c h a r a c t e r i z e d i n that said baffle (15) is fixedly joined to the inlet tube (9).

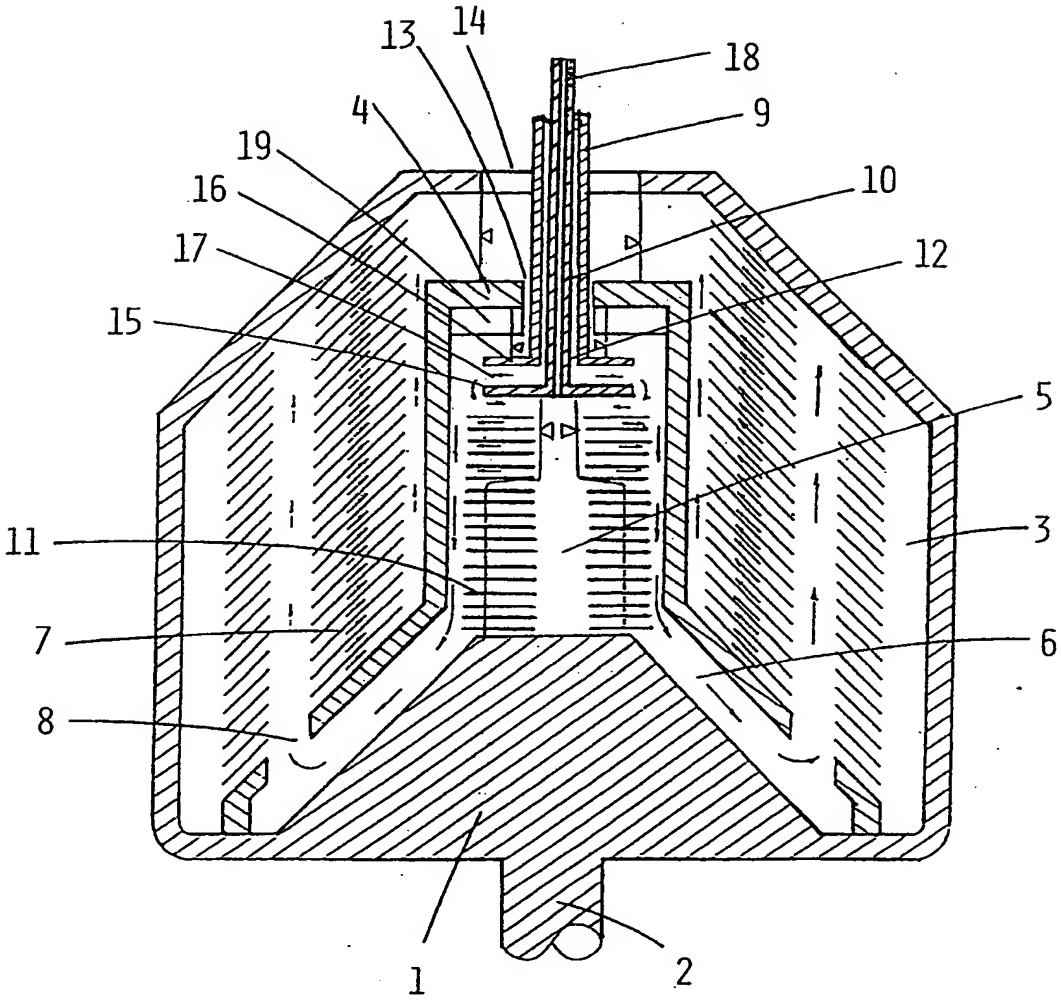


FIG. 1

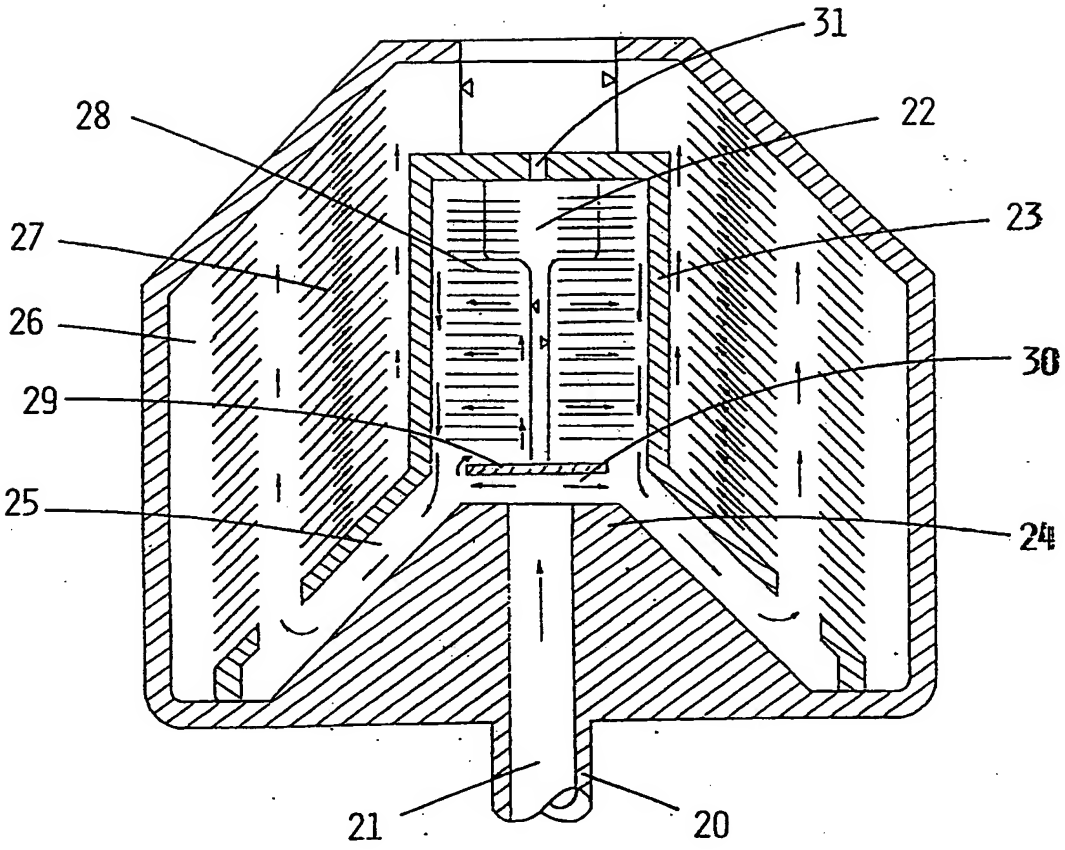


FIG. 2

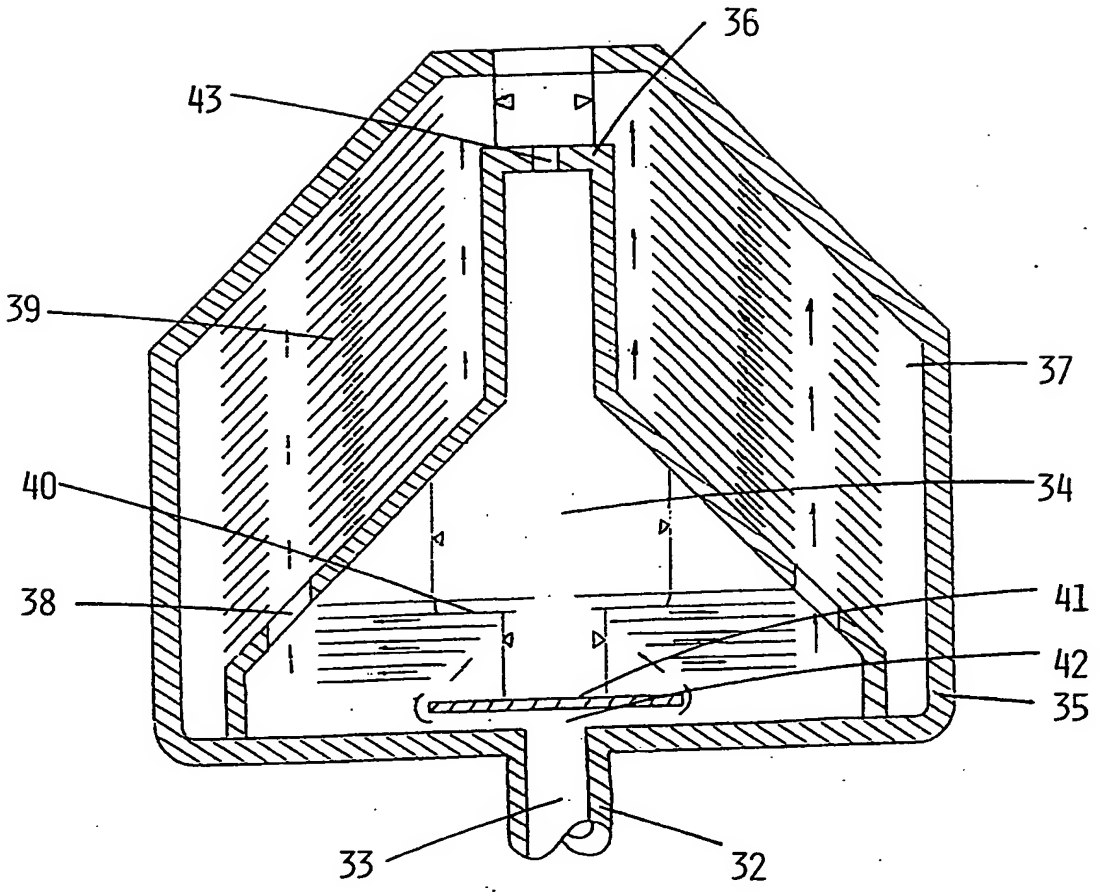


FIG.3

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 91/00100

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: B 04 B 11/06

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	B 04 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	US, A, 2302381 (A.T. SCOTT) 17 November 1942, see page 1, column 2, line 45 - page 2, column 1, line 13; figure 2 --	1-8
A	US, A, 4701158 (INGE ET AL) 20 October 1987, see the whole document --	1-8
A	US, A, 4721505 (INGE ET AL) 26 January 1988, see the whole document --	1-8

---

* Special categories of cited documents:[10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
7th May 1991	1991 -05- 15
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Åsa Fransson

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.PCT/SE 91/00100

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the Swedish Patent Office EDP file on 91-03-23
The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 2302381	42-11-17	NONE	
US-A- 4701158	87-10-20	EP-A-B- 0221723	87-05-13
		EP-A-B- 0225707	87-06-16
		JP-A- 62102846	87-05-13
		JP-A- 62102847	87-05-13
		SE-B-C- 450093	87-06-09
		SE-A- 8505128	87-05-01
		US-A- 4721505	88-01-26
US-A- 4721505	88-01-26	EP-A-B- 0221723	87-05-13
		EP-A-B- 0225707	87-06-16
		JP-A- 62102846	87-05-13
		JP-A- 62102847	87-05-13
		SE-B-C- 450093	87-06-09
		SE-A- 8505128	87-05-01
		US-A- 4701158	87-10-20